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Cover

Rollout!—Orbiter vehicle 101, christened the *Enterprise* by President Ford, was rolled out at ceremonies held at Palmdale, Calif., Sept. 17, 1976. NASA Administrator James C. Fletcher addressed a crowd of hundreds of people on hand for the event. In a dramatic sequence, Dr. Fletcher asked the question: "Is the Orbiter vehicle 101 ready for rollout?" The response was "yes," and to the accompaniment of a drum roll by the Air Force Band of the Golden West, the *Enterprise* turned the corner of the hangar and rolled up to the edge of the crowd of spectators. The band then launched into a stirring rendition of the theme song from "Star Trek."

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Correction—In the Sept. issue of NASA Activities, page 9, second column, 9 lines from bottom, range of heights is incorrect. Should read ". . . to 193 cm. (six feet four) . . ."

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Letter from Washington

Dear Colleagues:

Fletcher

In technological progress, as in the course of life, there are periods of transition. We began such a period last month with the rollout of the Shuttle orbiter, *Enterprise,* at Palmdale, California. The significance of that ceremony should not be lost on any American, and especially on any employee of the national space agency. The Shuttle's debut confirms that man has entered space permanently. We are accustomed to thinking of space exploration in terms of a handful of astronauts, in cramped compartments surrounded by instruments, and the prayerful moments as they returned to Earth in a flaming reentry. This was true of the old "seat of the pants" days of the Mercury pioneers, of the Gemini missions, and ultimately of Apollo's ascent to the Moon. But, following the last lunar landing, and using basically the same equipment, the three flights of the Skylab crews proved that human beings can live comfortably and work productively for prolonged periods in space.

Last year, the joint U.S.-Soviet Apollo Soyuz Test Project showed that spacecraft with divergent equipment, manned by astronauts of different nationalities, can dock in space and can perform rescue operations if needed. Experience has shown that people can inhabit the great unknown, the space environment, and function efficiently, with no major discernible aftereffects. The Space Shuttle represents a natural progression from our manned adventures.

The test flights will be made during the next three years. In 1980, we will send the Shuttle into near-Earth orbit. The crews—pilot-astronauts and mission specialists—will have to met stringent physical and mental standards but the passengers can qualify with normal good health. Only a short training exercise will be required for those making up the passenger manifest. Initially, they will be a variety of experts—astronomers, environmentalists, geologists—who will be experimenting in a long-term, gravity-free atmosphere. These scientists and technicians are going to manufacture in orbit as well. The Skylab flights of 1973 and 1974 taught us that certain forms of industrial application are more feasible in space. Crews on the Shuttle may make high-purity products such as alloys and pharmaceuticals. They will study the Sun, the sustainer of life on Earth, from a new vantage point. They will carry out surveys of Earth resources from their position of viewing our planet in its entirety.

Using its external manipulator, somewhat resembling the retractable claw of the Viking robot, the Shuttle can retrieve satellites for repair and maintenance. Or the spacecraft can bring the payloads back to Earth. Don't forget that some of our unmanned hardware have in the past malfunctioned and were lost. In the future, these payloads can be recovered, repaired and reactivated. The dollar savings can be enormous, and the savings in time, priceless.

From the start, the Shuttle program will have a strong international connection. A major planned payload is Spacelab, a large pressurized module with an external equipment pallet. The lab is being developed by ESA—the European Space Agency—and the 11 member nations are spending some $500 million to design and deliver the first unit to NASA. Spacelab will be durable. It is being designed to fly as many as 50 times over the decade of the 1980s. And we expect that newer and improved units will follow. The Canadians will contribute their essential Remote Manipulator System. Other countries are going to be submitting their innovations and ideas.

A Shuttle mission will generally last about seven days or it might run up to 30 days, followed by reentry. The spacecraft glides to a runway at the Kennedy Space Center and then lands, much like a conventional airliner. We estimate that refitting the Shuttle for the next flight could take as little as two weeks. It is quite a different story from the old "throwaway" days of launch vehicles and we will be paying a fraction of the costs. Every time we launched a Gemini or Apollo spacecraft, it was a one-time performance. All the intricate and expensive products of our technology were expended.

With Space Shuttle, both spacecraft and most of the launch equipment are returnable and reusable. After takeoff, the Shuttle expends its propellant rockets and they float to the ocean by parachute for recovery. The propellant tank is jettisoned just before the desired orbit is reached. As we progress in the many missions, preparation times will be shorter and operations simplified. Savings will be in the many millions of dollars. And because the Shuttle will be operating as a kind of scheduled carrier—for industry, scientific groups, foreign countries and others—both government and private expenditure will be lessened.

Debut of the *Enterprise*—This is how the Space Shuttle orbiter vehicle looked as it was rolled out of its hangar at the Rockwell International facility at Palmdale, Calif. Hundreds of people, including federal and state government representatives, foreign dignitaries, business leaders, NASA employees, news media personnel and other invited guests attended ceremonies marking the rollout, which began on the morning of Sept. 17.

By the mid-1980s, we anticipate that the flights into orbit and back will be routine. Although we are planning many exciting missions for the Shuttle, we have only scratched the surface. Once the Shuttle is operational and a fact of life, inventive and innovative minds will create uses difficult to envision now. The decade ahead will be an exciting one. What were dreams not so long ago will become reality. Man will come to feel at home in space.

Sincerely,

James C. Fletcher

James C. Fletcher

Monthly NASA Highlights

NASA Launches Navy Satellite

A NASA Scout D-1 configuration launch vehicle successfully launched the Navy's TIP-III (Transit Improvement Program) satellite from the Western Test Range on Sept. 1, 1976. The TIP-III satellite is the third development flight in a series of improved Design Transit navigational satellites.

The transit program is an operational navigation system used by the U.S. Navy and other vessels for world-wide ocean navigation. Currently five operating satellites are in the system. The TIP-III, with its improved operational characteristics, will be integrated into the Transit System.

The Navy reimburses NASA for the cost of the Scout launch vehicle, launch services, mission support requirements and supporting services.

NASA Aircraft Participates in FAA Demonstration

Several European countries, Australia and the U.S. have proposed concepts of a potential replacement system for the present aircraft landing system, which has been in existence for nearly 35 years. The need for its replacement has been evident for a considerable period. The International Civil Aviation Organization (ICAO) has established a panel representing 10 nations to review the concepts for a new system. The ICAO is the international body through which system acceptance and international standardization must be sought.

Demonstrations of the capabilities of the proposed U.S. Microwave Landing System (MLS) were conducted to strengthen the U.S. submission. On Aug. 3, Congressman Dale Milford (Texas) and two staff members attended a similar MLS demonstration and briefing at the FAA facility in Atlantic City.

The NASA B-737 from the terminal-configured vehicle program at the Langley Research Center was used in support of this FAA demonstration program. It is equipped to demonstrate the operation of the MLS. The craft made four demonstration flights with ICAO representatives aboard, completing 20 automatic three-dimensional area navigation paths, automatic approaches, and landings, all from an aft cockpit without any outside visibility. Before the demonstration, NASA's B-737 had made the first completely automatic landing ever conducted by a commercial type jet transport through use of signals from an MLS for landing flare guidance.

The NASA aircraft demonstrated two methods of automatic vertical flare guidance—using guidance from MLS and from a radar altimeter. Automatic curved descending approach paths also were demonstrated by the uniquely equipped NASA B-737.

A joint DOD/DOT/NASA planning group prepared a "National Plan for Development of the Microwave Landing System" in 1971. A systems concept for MLS is now being evaluated under the aeronautical operating systems program of the Office of Aeronautics and Space Technology.

Expanding Landsat Coverage

An agreement has been negotiated with the Pakistani government to locate a Landsat data-receiving station in Pakistan. The station will provide additional observation of Asian countries for the accumulation of data for the Large Area Crop Inventory Experiment (LACIE) project. The negotiations were important because such observations are considered critical to the success of the LACIE project.

Satellite Communications Improve

Communications between satellites improved greatly as a result of a five-year NASA program conducted at the Goddard Space Flight Center under the guidance control and information systems division, Office of Aeronautics and Space Technology (OAST). The program demonstrated unique engineering models of the two terminals for a high-data-rate intersatellite communications link using carbon dioxide lasers. A CO_2 laser emits a beam of 10.6 micro-meter wavelength.

In June 1976, an engineering model of a receiver terminal for synchronous satellites was tested. The receiver has the capability to acquire, track and demodulate a 300 Mbps (Megabits/second) data signal carried by the CO_2 laser beam. This year's program also produced the critical parts of an engineering model for a high-data-rate transmitter to be used in low altitude satellites. Parts included the 300 Mbps CO_2 laser transmitter and an optical antenna system.

The two terminals make it possible to relay wide-band data (the equivalent of three color television signals) from NASA's low-altitude Earth-sensing satellites to a synchronous relay satellite for real-time relay to a ground station. Thus, a sensing satellite can be linked to a ground station even when it is on the opposite side of the Earth. The system also can be used to link two synchronous satellites over either domestic or international distances.

Intersatellite widebank links will provide a new capability and flexibility in space communications in the 1980's with applications in NASA, commercial, and military spacecraft.

Help for Developing Countries

The Agency for International Development (AID) and NASA began their joint three-month demonstration of how space and advanced technologies can be used to benefit the people of developing countries. The programs in the demonstration project feature live two-way discussions between U.S. personalities and representatives of the countries receiving the program. A filmed portion presents material on communications technologies, remote sensing satellite capabilities and high-resolution aerial photography and how these capabilities can be applied to the problems in underdeveloped countries.

The AIDSAT demonstrations support Secretary Kissinger's commitment, made at the U.N. Conference on Trade and Development last May, to improve cooperation between industrialized and developing nations. AID is prepared to propose long-range, follow-up technology programs for interested countries.

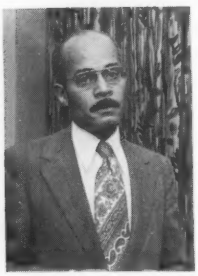
Informative Session for NASA Employees

Robert E. Smylie, Acting Associate Administrator for Aeronautics and Space Technology, led a presentation on aeronautics to NASA Headquarters employees on Aug. 26, 1976. Mr. Smylie presented an overview of the OAST aeronautics program, summarizing how NASA has played a major role in progress in aviation.

Donald P. Hearth, director of the Langley Research Center, discussed energy-efficient aircraft and NASA's research in structures, aerodynamics and noise. Bruce T. Lundin, director of the Lewis Research Center, talked about efficiency, pollution and propulsion as part of the energy-efficient aircraft effort.

The presentation was the second in a series designed to keep employees informed about NASA by direct communication from top management individuals. ■■■

New Personnel Director



Grant

Carl E. Grant has been named Director of Personnel for NASA, effective Sept. 5. He is responsible for personnel program administration agency-wide.

Grant was director of personnel, Small Business Administration, for five years before joining NASA. Earlier, he was associate director for personnel management resources administration at the Smithsonian Institution. He also has served in the personnel management field with the Civil Service Commission, Department of Defense, and the U.S. Army.

Grant was in the U.S. Navy from 1952 to 1956. He received a Bachelor of Science degree in Economics and Business Administration from the University of Detroit in 1960. He completed the executive development program at the Federal Executive Institute at Charlottesville, Va., in 1975.

Effects of Ocean and River Waters on Shuttle Components

Two NASA centers have completed successfully the first phase of a test program to determine the effects of salty and brackish (a mix of salt and fresh) water on materials being considered for use in the Space Shuttle.

The Marshall Space Flight Center and the Kennedy Space Center are testing materials being considered for use in the Solid Rocket Booster. The Shuttle is a reusable launch vehicle being developed by NASA for use in the 1980s.

Information concerning the effects of salt and brackish waters, water-borne contaminants and marine growth on the material is needed because the recovery of two boosters after each launch will involve towing them in the salty Atlantic Ocean and in the brackish waters of the Banana River (Fla.).

The recovery sequence involves separating and parachuting the used boosters into the Atlantic Ocean, from which they are captured by an ocean tug and towed back to KSC, including passage in the Banana River.

The tests were conducted using the boosters' integrated test bed which is 2.7 meters (eight feet) long and three meters (10 feet) in diameter. The test bed was constructed from the same materials and protected from corrosion with the same sealants and paints as planned for use on the actual flight.

The test bed then was shipped to KSC where it was placed in the ocean for seven days and in the Banana River for three days. The depth of the test item in the water, 80 percent submerged, was very closely controlled to simulate actual booster recovery conditions.

The test bed then was returned to the Marshall center where engineers and technicians examined it to determine what effects the ocean and river environments had created. Inspections are for such things as corrosion and marine biological growth.

On completion of this study in September, the second phase of the test program began when the refurbished test bed was again placed in the ocean by KSC personnel.

The Marshall center is responsible for development of the solid rocket booster and for the Space Shuttle main engine.

The orbiter, which will carry the crew and payload, is being developed under the direction of the Johnson Space Center.

The Kennedy center will be the launch site of the Space Shuttle vehicles and the primary orbiter landing site. The center is responsible for Space Shuttle assembly, checkout, launch and refurbishment of orbiters upon completion of their missions.

Researching Ceramic Materials

Research into the nature and properties of ceramic materials being carried on at the University of Washington's division of ceramic engineering has received a $300,000 grant from NASA's Office of Aeronautics and Space Technology at Washington, D.C.

The grant, tentatively scheduled to be renewed annually during the next 10 years, will be used to develop an educational program in which engineering design students can become familiar with the properties of ceramic materials and basic research on these materials can be expanded.

The search for new materials capable of withstanding high temperatures and exhibiting physical properties needed for ever-increasing applications recently has involved research in the field of engineering. Fiberglass, optical communications systems, nuclear fuels, catalytic converters, self-cleaning ovens and ceramic counter-top ranges, human implants not affected by the body's rejection mechanisms, eyeglasses which darken in the sunlight—all have been made possible through engineering contributions to this rapidly expanding field.

Despite the significant advances in ceramics technology, many design engineers schooled in the use of more conventional materials are still somewhat uncomfortable working with ceramics. They tend to retreat to materials with which they are more familiar in solving design problems, according to Professor James I. Mueller, head of the university's ceramic engineering division.

"We felt that the best approach to overcoming this problem would be to familiarize engineering students at both the undergraduate and graduate levels with the nature of ceramics and their behavior in hostile environments by having them go through the mechanics of a controlled design problem which would require the use of ceramics," Mueller said.

The controlled design problem to which Mueller referred involves the development of gas turbine engine components capable of withstanding sustained high temperatures and severe mechanical stresses and on methods by which the parts can be manufactured economically.

Among many potential bonuses that might be realized from ceramic research are small gas turbines that could operate up to 1,500 degrees Celsius (3,000 degrees Fahrenheit), a temperature far beyond that at which metal turbines would be practical; could provide power comparable to a contemporary eight-cylinder automobile engine; get more than 80.45 kilometers (50 miles) to the gallon; and, because of the complete combustion at such a high temperature, emit virtually no pollutants into the atmosphere.

The project is interdisciplinary. Although it is under the direction of the division of ceramic engineering, it also will involve students and faculty in other departments: aeronautics and astronautics; civil, mechanical, metallurgical and electrical engineering; and physics.

Lending expertise to the project will be companies and agencies that have been involved in extensive research projects involving ceramic applications to turbine technology. These include the Ford Motor Co., Westinghouse, the U.S. Army, and others, whose representatives will serve on an advisory committee to provide the benefits of their experience.

Prospectus

The Moon Missions

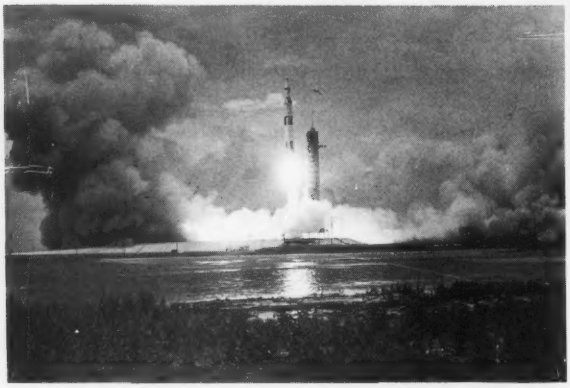
As the decade of the 1960s ended, the stage was set. Man would accomplish one of the most incredible feats of all time: he would walk on another planet. The United States was committed to landing men on the Moon before 1970. The pioneering days of Mercury were behind. Project Gemini had been completed, and space science had reached the ultimate dimension in flight crew and ground support efficiency. More than 400,000 NASA and contract personnel were building the Apollo program. In seven years, the national space agency had progressed from an Atlas/Mercury spacecraft configuration, capable of holding one man and with a compartment length of almost seven feet, to the Saturn V Apollo vehicle, carrying three men and producing more than nine million pounds of combined three-stage thrust. Momentum was building apace. Then, tragedy—the men of the astronaut corps suffered their first casualties in the space endeavor.

It was Jan. 27, 1967, a routine ground test. A sudden flash of fire inside the Apollo spacecraft. Gus Grissom, the second American to fly in space, Ed White, the first American to walk in space, and Roger Chaffee perished in their silver flight suits. An appalled nation, a shocked Congress halted the Apollo program.

Months of inquiry and weeks of testimony before Congressional committees followed. NASA scientists engaged in an intensive materials test and development project, inventing a hatch cover that could open in seconds, and altering basic designs for safety. The interrupted schedule for Moon flight was resumed.

On Oct. 11, 1968, the team of Schirra, Eisele, and Cunningham made the first manned flight of Apollo, using the spacecraft command-service module. The mission was carried out without complication and the splashdown in the Atlantic was within 10 miles of the

Waiting to Begin Apollo 10—Astronauts Cernan, Stafford and Young (l. to r.) prepare for the lunar orbit mission accomplished in 1969. Their spacecraft circled the Moon from a 69-mile altitude while the lunar module separated and approached to within 10 miles of the lunar surface.



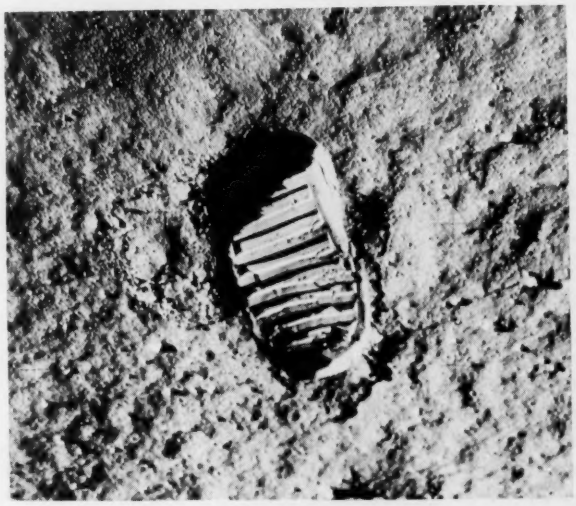
Preliminary to Moon Landing—The historic liftoff of a 363-foot-high Apollo/Saturn V space vehicle which carried Stafford, Young and Cernan into Moon Orbit took place May 18, 1969 at the Kennedy Space Center.

predicted landing point. The dream was revived and the activity heightened. The Kennedy Space Center became one of the busiest locales in the world.

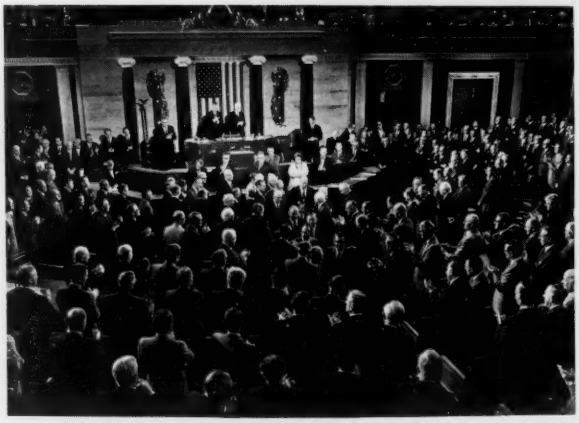
Presidents, kings, heads of state asked for front row seats to watch an Apollo launch. Millions of others saw the majestic rise of an Apollo-Saturn via television and satellite. America was nearing its four key goals: to establish the technology to carry out the national interests in space; to achieve U.S. preeminence in space; to carry out a scientific exploration of the Moon; and to develop man's capability to function on the lunar surface. Above all, the objective was to land Americans on the Moon and return them safely to Earth.

In December of 1968, Frank Borman commanded the first flight to the Moon's atmosphere, making 10 revolutions of the dead planet and televising views of the lunar surface for reception on Earth. A few months later, on March 3, 1969, Jim McDivitt was the skipper on Apollo 9, the first manned mission of the lunar module, and Rusty Schweickart made a 37-minute space walk. The tempo of the Moon mission project was rising quickly.

In May, the Apollo 9 crew of Stafford, Young and Cernan completed the first lunar module orbit of the Moon, returning to a flaming, spectacular reentry in the pre-dawn hours over the Pacific. The moment was approaching.



First Human Footprint on Another Planet—Astronauts Armstrong, Collins and Aldrin formed the historic Apollo 11 team that landed men on the Moon July 16, 1969. Armstrong and Aldrin took Moon walks on July 20; Collins was in charge of the command module. Splashdown on Earth took place in the Pacific Ocean July 24.



Congress Applauds Space Pioneers—The Apollo 11 Astronauts Collins, Armstrong and Aldrin received a standing ovation after addressing a joint Congressional session on September 1969.

Apollo 11 lifted off the pad on Merritt Island on July 16. At NASA Headquarters, at Mission Control in Houston, at the space centers and the deep-space tracking networks, all over the civilized world—humanity waited for the transmission. It came at 4:18 p.m. (EDT), July 20—"the Eagle has landed." The spacecraft was resting on the Sea of Tranquility. A short time later, the world heard a heavily-breathing Neil Armstrong announce that one small step and the giant leap had been made.

Six Apollo missions were to follow. One, Apollo-Saturn 13, never got to the lunar surface. The service module oxygen tank ruptured near the Moon and the terse statement came to Earth: "Houston, we've got a problem." People of all nations, of every political order, prayed for a safe return. And Lovell, Swigert and Haise, using lunar module power and oxygen, splashed down without mishap in the Pacific on April 17, 1970.

Twelve Americans roamed the Moon, by foot and by Lunar Rover, totaling nearly 200 man-hours of exploration. They ranged 60 miles on the surface and carried back some 850 pounds of soil and rocks. They conducted 34 experiments in lunar orbit and placed 60 major experiments on the Moon itself. But more than these material achievements, the astronauts and their ground support units threw open the corridors of space. The human race, after centuries of superstition and ignorance, after a century and a half of stunning advances in science and technology, had entered a new world. The condition of man would never again be the same. The United States government, the National Aeronautics and Space Administration and the American people unlocked the portal that had mystified humans since time began.

Wernher von Braun, one of the brilliant architects of rocketry and space exploration, recently spoke of Apollo and more recent accomplishments with these words: "The space program already has produced unexpected blessings and byproducts too numerous to list. But we should never forget that it all started as a dream . . . we invite all who are young at heart and believe in a continued material and spiritual growth of mankind to join with us . . . the Earth does not pose a limit . . . our limit is the sky." ■■■■

Powerful Digital Computer Readied

A milestone in preparations for the Space Shuttle program was reached recently with NASA's acceptance of the Univac 1100/46 computer system, a sophisticated computer complex that will drive the Shuttle mission simulators.

"Prior to acceptance, thirty days of round-the-clock testing was conducted here at the NASA Johnson Space Center and the computer complex operationally demonstrated reliability far in excess of contractual requirements," said Dr. Bruce B. Johnson, technical manager of the contract.

Completed three weeks ahead of schedule by the Sperry Rand Corp., Sperry Univac, the Univac 1100/46 consists of 10 processors, making it one of the most powerful digital computers built to date. It has 900,000 36-bit words of main memory and two billion characters of mass storage. Its speed is measured in MOPS (millions of operations per second), having demonstrated 2.14 MOPS with some unmeasured reserve.

Center director Dr. Christoper C. Kraft, Jr., was present for the acceptance ceremonies of the Shuttle Mission simulator computer complex, and presented group achievement awards to the Sperry Univac and NASA project teams for a job well done.

Following acceptance, the Univac 1100/46 was turned over to the Singer Company's simulation products division for software development and integration into the Shuttle mission simulators. The simulators will be used to train flight crews and ground personnel in all phases of the Space Shuttle program.

The computer, a multipurpose processing system, will simulate a wide range of mission situations associated with major flight phases including: pre-launch, ascent, aborts, orbit rendezvous, docking, payload handling, undocking, de-orbit, entry, landing and rollout on the runway.

In March 1978, the simulators will begin supporting all flight phases and modes of operation including operating in an integrated mode with the mission control center. The first orbital flight of the Shuttle is scheduled for the spring of 1979.

The unique procurement system for the computer complex devised by JSC personnel included a fixed price, standard form contract, with selection based on the oriented specifications. Total cost of the contract is $7,934,876.

Smylie Takes New Job

Smylie

Robert E. Smylie recently was appointed Acting Associate Administrator for the Office of Aeronautics and Space Technology at NASA headquarters. Smylie directs NASA research and technology to meet the nation's future requirements in areonautics and space. Related programs cover a broad range of scientific and engineering disciplines carried out at the various NASA centers.

Smylie was employed by the Douglas Aircraft Company before joining the space agency in 1962.

During the 1960s, Smylie held various key assignments in support of the Apollo manned lunar exploration program and was the U.S. chairman of the working groups concerned with crew transfer and life support systems for the U.S.-Soviet Apollo Soyuz Test project. He served as city councilman in El Lago, Texas, in 1970 and 1971.

Smylie graduated cum laude from Mississippi State University in 1952 and earned a Master's Degree in Mechanical Engineering from MSU in 1954. He completed the requirements for a Master's Degree in Management as a Sloan Fellow at MIT in 1967. He also has done graduate work at UCLA.

He has received many honors and awards including the NASA Exceptional Service Medal and the Victor Prather Award. In 1975, he was elected an honorary member of the American Society of Heating, Refrigerating and Air-conditioning Engineers. Fourteen men have been so honored by the Society in the past, including Milton S. Eisenhower, Herbert C. Hoover and Theodore von Karman. The award was given for Smylie's work in the design, development, and testing of environmental and life support equipment for the U.S. Apollo astronauts.

Oblique Wing Craft Flies Successfully—The oblique-wing remotely piloted research vehicle took off on its first flight from a dry lakebed at NASA's Dryden Flight Research Center in southern California. NASA's Ames Research Center pilot Jim Martin was at the controls in a specially equipped van on the lake-bed as the plane flew over the Mohave Desert. During the 25-minute flight, the RPRV flew an oval-shaped course at approximately 2,000 feet over the lakebed with its wing at 15-, 30- and 45-degree angles to the fuselage. Along with providing stability and control data on the various wing angles, the flight was a checkout of performance verification and autopilot efficiency.

Oblique-Wing Aircraft under Study

Last August, NASA engineers began flight-testing a unique remotely controlled aircraft that can fly with the wing positioned at various oblique angles to the flight path. The flight-test program is a joint effort of NASA's Dryden Flight Research Center and Ames Research Center.

The small aircraft, called an RPRV (for remotely piloted research vehicle), flew for the first time on Aug. 6 at the Dryden center. The purpose of the flight program is to verify wind tunnel, flight-simulator and theoretical studies made at Ames for flight characteristics of oblique-wing aircraft.

The craft is equipped with instrumentation to record its flight characteristics—the first oblique-wing aircraft to fly so equipped. The information recorded by the instruments will allow research scientists to verify analytical methods developed to calculate the flight characteristics of these advanced technology aircraft.

Dr. Robert T. Jones, a senior scientist at Ames, has proposed an oblique-wing transport aircraft with a pivoting straight wing mounted on the top of the fuselage. The wing can be turned to various oblique angles for best performance at different flight speeds. For slower flight, the wing is positioned at right angles to the fuselage, allowing landings and takeoffs with a minimum of power and much less noise than present-day supersonic transports. For higher speeds, the wing is rotated with respect to the fuselage to gain the high-speed efficiency of the swept-wing design.

Studies have indicated that an oblique wing transport airplane flying at 1,609 kilometers per hour (1,000 m.p.h.) would achieve about twice the fuel economy of either the British-French *Concorde* or the Russian SST.

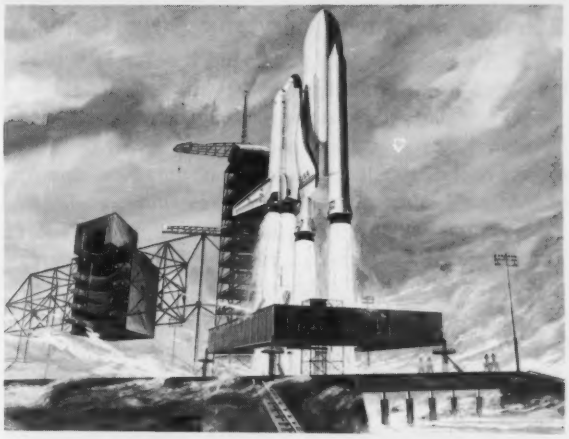
The oblique-wing RPRV under testing represents a low-cost approach to early assessment of advanced technology. It has a wing span of 6.7 meters (22 feet), weights 400 kilograms (900 pounds) and is powered by a four-cylinder, 90-horsepower engine. The wing angle relative to the fuselage can be varied during flight. Wing angles up to 45 degrees will be tested. The RPRV is flown from a ground cockpit by radio control. A television camera mounted in the aircraft's nose gives the pilot on the ground a "pilot's eye" view.

The RPRV technique was developed by engineers at the Dryden center as a highly cost-effective means of flight-testing high-risk technology without the associated risks to the test pilots. It involves flying large-scale models of the test aircraft by a test pilot located in a ground cockpit complete with flight controls and struments. The pilot is able to fly the model through the desired test maneuvers using radar, television and telemetry.

The first application of the new technique was spin testing of a 23-foot model of the USAF F-15 fighter.

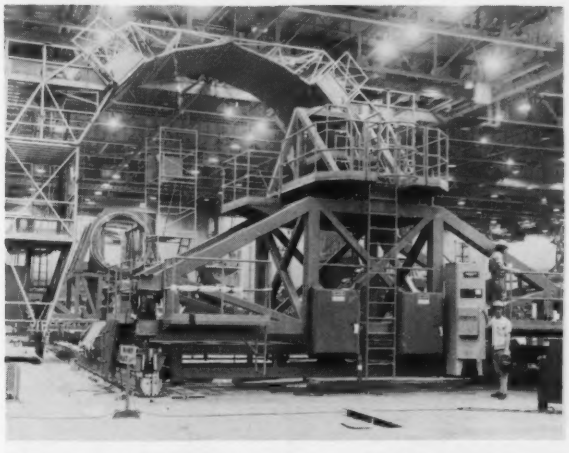
CTS Declared a Success—One of 30 original launch postal cancellation signature cards of the Communications Technology Satellite was presented to NASA's Lewis Research Center director Dr. Bruce T. Lundin (fourth from left) by key Lewis personnel involved in the project. In addition to the signatures of principal investigators of the experiments and managers of the U.S. CTS program, CTS user experiments also are depicted on the rare card, which commemorates the historic event.

A U.S. postage stamp citing a century of friendship between the U.S. and Canada, and a sticker stating the exact time of the CTS launch (Jan. 17, 1976) also are on the card. The presentation marked the declaration by NASA that CTS, a joint U.S.-Canada venture, is a mission success. Others attending the presentation are (left to right) Dr. Seymour C. Himmel, associate director, Flight Programs; Daniel J. Shramo, director, Space Flight Programs; William H. Robbins, manager, CTS Project Office; Dr. Lundin; Robert E. Alexovich, chief, Communications Technology Branch; Patrick L. Donoughe, manager, CTS U.S. Experiments; and Henry W. Plohr, chief, Spacecraft Technology Division.



Earth-Shaking Future Event—A tremendous thrust generated by engines and boosters will lift Space Shuttle off its Kennedy Space Center pad in 1980. Before the components—orbiter, Space Shuttle main engine, external tank and solid rocket booster—are mated and ready for launch, numerous tests will have been carried out at the Dryden Research Center and the Marshall Space Flight Center.

Outstanding Career Woman—Karen E. Miller, a public information specialist at the Langley Research Center's office of public affairs and educational programs, was named "Outstanding Young Career Woman" for 1976-77. The title was bestowed on Miller by the Virginia Peninsula Chapter, Business and Professional Women's Club. In 1975, Miller, 26, was voted an "Outstanding Young Woman of America" by the Young Women of America organization. Miller, a native of Fort Knox, Ky., is a graduate of Virginia Polytechnical Institute and State University, where she majored in English. She has been employed at the Langley center since 1973.



Huge Shuttle Fixture—This structure at the NASA's Michoud Assembly Facility is believed to be the largest horizontal, rotating weld fixture in the world. The fixture is to be used by Martin Marietta Aerospace in manufacturing the liquid hydrogen tank section of the Space Shuttle external tank. The tank will be 8.4 meters (27.6 feet) in diameter and 47 meters (153.7 feet) long, will weigh 34,000 kilograms (75,000 pounds) empty and will hold 703,000 kilograms (1.55 million pounds) of liquid hydrogen and liquid oxygen. The hydrogen tank will constitute about two-thirds of the external tank. NASA's Marshall center, of which the Michoud facility is a part, is responsible for development of the external tank, the Space Shuttle main engine and the solid rocket booster.

Satellite Monitors Maryland Strip Mines

The State of Maryland has found a different way of looking at its strip-mining activities for coal.

The new perspective stems from a recently completed NASA/Maryland project involving the monitoring of surface coal mining through the use of data from one of NASA's Landsat earth resources satellites.

Landsat-1, which circles the Earth at an altitude of 912 kilometers (570 miles), has sent back imagery showing that 25 to 30 percent more acreage was affected by the strip mines than had been realized. Consequently, Maryland has modified its inventorying procedures to include the additional mining acreage involved.

For the monitoring project, special computer-generated images were developed that identified surface mines. Location and size of the mines then were verified by field inspection, aerial photography and published state statistics.

Analysis of the images by Arthur T. Anderson of NASA's Goddard Space Flight Center Information Transfer Laboratory resulted in identification, classification and measurement of the effects of coal strip-mining in the state's western area. Comparisons of Landsat imagery taken over a three-year period ending in 1974 showed that about 93 percent of the surface in the region studied was disturbed by the mines.

"Our cooperative study [with the Maryland Bureau of Mines and state geological survey personnel] clearly demonstrated the feasibility of monitoring coal strip mines by satellite remote sensing. While this method cannot replace ground surveying, it can provide valuable information to complement the state's present field inspection program," Anderson said.

Another aspect of the Maryland inventory and mapping program of all strip-mined land in its coal-producing area involves the location and extent of orphan mines (mines abandoned before 1967).

Maryland's coal strip-mine law, enacted in 1967 and subsequently updated, requires private companies to operate under state-approved, bonded, reclamation plans. Acreage distributed before 1967 is to be reclaimed by the state with the cooperation of the mining industry.

According to Anderson, the Landsat pictures developed for active mines in the joint study can be used as a relatively inexpensive means to locate and rapidly measure the earlier mines.

A number of other states have undertaken Landsat data projects similar to the Maryland study for inventorying areas surface-mined for coal and other nonmetallic materials. These include Ohio, Tennessee, West Virginia, Kentucky, Pennsylvania, South Carolina, Florida, New Mexico, Montana, Wyoming, Colorado, Arizona, Utah and Oregon.

Strip-Mining Effects—Arthur Anderson of NASA's Goddard Space Flight Center (left) and Monte Nock of the Maryland Geological Survey view an operating coal strip-mine in Maryland. Anderson has said that savings are substantial when satellite survey techniques are used. "Such savings are significant, particularly in light of the current demand for large quantities of data by legislative councils and State agencies embroiled in the surface mining controversy," he added.

Eroded Lands Restored—Abundant grass grows on a reclaimed coal strip-mine in Maryland. Such reclaimed areas are of importance to national efforts to restore the environment to good health. The Federal Bureau of Mines estimates that of the more than two million acres of land affected by strip-mining for coal, only about a third of that acreage has been reclaimed. Half of all the coal mined in the United States is obtained by surface mining.

Two Landsat satellites presently circle the globe in polar orbits and provide repetitive coverage of a given area every nine days.

Data recorded by the satellites are telemetered in digital format to a ground station where they are recorded on magnetic tapes which can be manipulated directly by a computer to develop special images such as those used in the Maryland study.

Barren Landscape in Wake of Strip-Mines—This unreclaimed coal strip-mine in Maryland is one of those in the state's reclamation program. Surface- or strip-mining has become a controversial subject in a number of states because of evidence that it poses environmental hazards which include erosion, water pollution and loss of productive land.

Recorded information also can be converted into conventional negatives by computer for printing black-and-white or false-color images. Green, red and infrared are normally combined to reveal healthy vegetation as bright red.

Landsat images measure 185 by 185 kilometers (115 by 115 miles) to provide a total area per image of 34,965 square kilometers (13,500 square miles).

Ground features can be distinguished in these images based on the visible and near-infrared energy emitted by each feature. Unique signatures can be developed for numerous features, whether they are healthy or sick vegetation, water, geologic structures, or city and industrial areas.

Landsat data already have revolutionized map-making, and its implications for crop-yield estimations, ice-flow warnings for ships, and water management and assessment are far-reaching. Coastal zone analysis, mineral exploration, and geological sciences are among the many other areas now benefitting from analyses of Landsat imagery by scientists around the world.

Landing on the Planet Mars

Editor's Note: Although we will know much of the outcome of the Viking mission by the time this and the next two segments of Dr. Carl Sagan's six-part series are published, his account of the many considerations and risks that had to be weighed and measured in advance sheds considerable light on the complex venture.

The Soviet Union has an extremely active program of unmanned planetary exploration. Every year or two the relative positions of the planets permit the launch of a spacecraft to Mars or Venus at minimum energy. Since the early 1960s the USSR has missed only two or three such opportunities. Soviet persistence and engineering skills have eventually paid off handsomely. Three spacecraft—Veneras 8, 9 and 10—have landed on Venus and successfully returned data from the surface of that planet. Since Venus is at a broiling 480 degrees Celsius (900 degrees Fahrenheit) with a crushing atmosphere 95 times as dense as the Earth's and with significant quantities of corrosive atmospheric acids, landing and returning data from that planet is no insignificant feat. Yet, despite many attempts, the Soviet Union has been unsuccessful in attempts to land on Mars—a place which superficially seems to be much more hospitable, with lower temperatures, a thinner atmosphere and no corrosive gases.

In 1971, the Soviet Mars 3 spacecraft entered the Martian atmosphere. According to the information automatically radioed back, it successfully deployed its landing systems during entry, oriented its ablation shield correctly downward, properly unfurled its great parachute and fired its retrorockets near the end of its descent path. According to the data returned by Mars 3, it should have successfully landed on the Red Planet. But, after landing, the spacecraft returned to

Selecting a Martian Runway—Overlapping electronic images of surface features on Mars produce a mosaic that reveals potentially safe landing sites. Photos are taken by the Viking orbiter's two television cameras, then transmitted to Earth. Site selections for Viking lander touchdown were made after photos were studied by Viking scientists at NASA's Jet Propulsion Laboratory.

Digging Martian Dirt—An artist's rendition of a sampling arm of the Viking lander scooping up a quantity of soil on the surface of Mars. The soil is deposited in an organic analysis chamber aboard the lander. Subsequently, details concerning the sample are beamed back to NASA scientists on Earth who seek to ascertain whether the soil contains evidence of life on Mars.

Earth a 20-second fragment of a featureless television picture and then mysteriously failed. In 1973, a quite similar sequence of events occurred for the Mars 6 lander, but in that case the failure occurred within one second of touchdown. What is the source of these failures? Is there something special about the Martian environment that makes landing on that planet particularly difficult?

The first illustration I ever saw of Mars 3 was a Soviet postage stamp (denomination 16 kopeks) which depicted the spacecraft descending through a kind of purple muck. The artist was trying, I think, to illustrate dust and high winds: Mars 3 entered the Martian atmosphere at a time of an enormous global dust storm which roared over the planet.

We have evidence from the United States Mariner 9 mission that near-surface winds of more than 322 kilometers per hour (200 m.p.h.)—more than half the speed of sound on Mars—occurred. Both our Soviet colleagues and we think it likely that these high winds caught the Mars 3 spacecraft with parachute unfurled, giving it a very high velocity parallel to the surface, so that it landed gently in the vertical direction but with breakneck speed in the horizontal direction. A spacecraft descending on the shrouds of a large parachute is particularly vulnerable to horizontal winds. After landing, Mars 3 may have made a few bounces, hit a boulder or other example of Martian relief, tipped over, lost the radio link with the carrier "bus" spacecraft, and failed.

But why did Mars 3 enter in the midst of a great dust storm and high winds? The answer is that the Mars 3 mission was rigidly organized before launch. Every step it was to perform was loaded into the on-board computer before it left Earth. There was no opportunity to change the program, even as the extent of the great 1971 dust storm became clear. In the jargon of space exploration, the Mars 3 mission was preprogrammed, not adaptive.

The failure of Mars 6 is more mysterious. There certainly was no great global sand and dust storm when it entered the Martian atmosphere, and no reason to think that there was a local storm then—as sometimes happens—at the landing site. Perhaps there was an engineering failure just at the moment of touchdown, although such a coincidence makes this explanation a little unlikely. Or perhaps there is something dangerous about the Martian surface.

The combination of Soviet successes in landing in so inhospitable an environment as Venus and Soviet failures at landing on Mars naturally caused some concern about the U.S. Viking mission to Mars. Like its Soviet predecessors, the Viking landing maneuver involves an ablation shield, a parachute and retrorockets. Under what circumstances might Viking fail its critical landing maneuvers?

Because the Martian atmosphere is only one percent as dense as the Earth's, a very large parachute—18 meters (55 feet) in diameter—is deployed to slow down the spacecraft as it enters the Martian atmosphere. The atmosphere is so thin that if Viking should land at a high elevation there is not enough atmosphere to adequately brake the descent and avert a crash at the spacecraft. One requirement, therefore, is for a landing site in a low-lying region. And from Mariner 9 results and ground-based radar studies of Mars, we know many such low-lying areas.

To avoid the probable fate of Mars 3, we want Viking to land in a place and time when the winds are low. The winds which will make the lander crash are probably already strong enough to lift dust off the surface. If we can check that the candidate landing site is not covered with shifting, drifting dust, we have at least a fair chance of guaranteeing that the winds are not intolerably high.

This is one reason that the Viking lander is carried into Mars orbit with the orbiter and descent is not made until the orbiter checks out the landing site. We discovered with Mariner 9 that characteristic changes in bright and dark patterns on the Martian surface occur during times of high winds. We certainly would not certify the landing site as safe if orbital photographs showed such patterns. But our guarantees cannot be 100 percent reliable either. For example, we can imagine a landing site on which the winds are so strong that all mobile dust has already been blown away. We would then have no indication of the high winds which might be there. Detailed weather predic-

tions for Mars are, of course, much less reliable than for Earth. (Indeed one of the many objectives of the Viking mission is to improve our ability to understand the weather on both planets.)

Because of communications and temperature constraints, Viking cannot land at high Martian latitudes. Farther poleward than about 45 or 50 degrees in either Martian hemisphere, either the time of useful communication of the spacecraft with the Earth or the period when the spacecraft experiences temperatures above the fatally low mark would be awkwardly short.

We do not wish to land in too rough a place. The spacecraft might tip over and crash or, at the least, its mechanical arm to acquire Martian soil samples might become wedged or wave helplessly above the surface. Likewise, we do not want to land in places that are too soft. If the three landing pods sink deeply into a loosely packed Martian surface, various undesirable consequences would follow, including immobilization of the sample arm if the spacecraft sinks too far. But we do not want to land in a place which is too hard either—if we land in a vitreous lava field, for example, with no powdery surface material, the mechanical arm would be unable to acquire samples vital to the chemistry and biology experiments.

Now it is not easy to determine the roughness or softness of a candidate landing site. The best photographs of Mars—available from the Mariner 9 orbiter—show features no smaller than 90 meters (100 yards) across. The Viking orbit pictures will improve this figure only slightly. Boulders one meter (3 feet) across will be entirely invisible in such photographs, but could have disastrous consequences for the Viking lander. Likewise, a deep, soft powder might be indetectable photographically.

Fortunately there is a technique which permits us to determine the roughness or softness of a landing site. That technique is radar. A very rough place will scatter radar off to the sides and therefore appear poorly reflective. A very soft place will also appear poorly reflective because of the many interstices between individual sand grains. While we may be unable to distinguish between rough places and soft places, we need not make such a distinction for the Viking landing purposes. Both are dangerous. Preliminary radar survey suggests that as much as a quarter to a third of the surface area of Mars may be poorly reflective to radar and therefore dangerous for Viking. But not all of Mars can be viewed by Earth-based radar—only a swath between about 25 degrees N. and about 25 degrees S. The Viking orbiter contains no radar system for mapping the planetary surface.

There are many constraints. Our landing sites must be low, not too windy, not too close to the pole, not too hard or soft or rough. It is remarkable that there are any places at all on Mars which satisfy simultaneously all of these safety criteria. What is even more remarkable is that some of these candidate landing sites are of intense scientific interest.

When a Viking orbiter-lander combination is inserted into Martian orbit it is unalterably committed to landing at a certain latitude on Mars. For example, if the low point in the orbit is at 21 degrees Martian north latitude, the lander must touch down at 21 degrees north latitude, although—by waiting for the planet to turn beneath it—it can land at any *longitude* whatever. Thus, the Viking teams have selected candidate latitudes on which there are more than one promising site. Viking 1 is now targeted for 21 degrees N. The prime site is in a region called Chryse which is near the confluence of four sinuous channels thought to have been carved in previous epochs of Martian history by running water. The site in Chryse (which is Greek for the land of gold) seems to satisfy all of the safety criteria. But radar observations have so far been made only nearby, not in the Chryse landing site. The appropriate radar observations can be made—because of the geometry of Earth and Mars—for the first time only a few weeks before the nominal landing date.

The present candidate latitude for Viking 2 is 44 degrees North. The prime site for the second landing in a locale called Cydonia, was chosen because—according to some theoretical arguments—there is a significant chance of small quantities of liquid water there, at least at some time in the Martian year. Since the Viking biology experiments are strongly oriented towards organisms which are comfortable in liquid water, some scientists hold that the chance of Viking finding life on Mars is substantially improved at the selected site. On the other hand, it is argued that on as windy a planet as Mars microorganisms should be everywhere if they are anywhere. There seems to be merit to both positions and it is difficult to decide between them. What is quite clear, however, is that 44 degrees N. is completely inaccessible to radar site certification; therefore we must accept a significant risk of failure of Viking 2 if it is committed to high northern latitudes. It is sometimes argued that if Viking 1 is down and working well we can afford to take a risk with Viking 2. But I can imagine other sets of circumstances. To at least improve the Viking options, additional landing sites in the radar-certified region over four degrees south latitude have also been selected. A decision on whether Viking 2 sets down at high or at low altitude will be made virtually at the last minute.

The nineteenth century British prime minister, Benjamin Disraeli, was asked to define the difference between a calamity and a catastrophe. "If my opponent, Mr. Gladstone, fell into the Thames, that would be a calamity," he said. "If someone pulled him out, that

would be a catastrophe." If Viking failed to find life on Mars because it did not land in a wettish place, that would be a calamity. But, I think, if Viking failed to return any data at all, that would be a catastrophe.

If Viking lands successfully on Mars it will be due in considerable part to the great skill devoted to its design, fabrication and testing and to the abilities of the spacecraft controllers. But it will, I think, for so dangerous and mysterious a planet as Mars, also be due to at least an element of luck. ■■■■

Spacecraft May Produce Future Surveys of Earth Traffic

Traffic surveys may very well be undertaken by satellites such as NASA's Landsat and Seasat in the 1980s, using techniques that may be capable of providing near-instant analyses of pictures from Earth.

The possibility of such usage of space sensors first came under consideration when the New Orleans Planning Commission asked NASA's Marshall Space Flight Center if space technology might be used to provide an automated method of conducting reliable and inexpensive traffic surveys.

Marshall center engineers suggested that an optical processing technique used to recognize objects or patterns in aerial or space imagery might be adaptable to the problem. The technique, which is based on the scanning of photographic transparencies with a laser beam, was developed at the Marshall center several years ago. The adaptation was patented by its inventor, Joseph H. Kerr, an engineer at MSFC.

"The system can be compared to the eyes looking at an object and the mind recognizing it," said Kerr.

In a traffic survey system, an aerial camera photographs the target area at periodic intervals, resulting in a transparency of each photograph. When the transparencies are placed in the newly developed laser scanner, the system senses the differences in intensities of the filtered beam, recognizes vehicle sizes and shapes, and stores data about size and location for use when needed. Such data can be in the hands of users in a few hours.

Present methods of processing data from orbiting satellites sometimes involve several months. Kerr estimates that survey data from his system could be in the hands of the user 100 times faster than today's processing by digital and analog computers.

Less sophisticated methods of surveying traffic patterns consist of workers with counters, air-filled hoses across streets, or closed circuit cameras tied to a digital computer. Such methods are often costly in time and money, and the data may be obsolete before users receive results.

The NASA-developed system of surveying traffic must start with photographs taken from aircraft, Kerr said. At present, traffic suveys cannot be made from the Landsat satellites inasmuch as they pass over the target area only once in 18 days. But the present traffic project gives NASA the chance to refine the scanning technique for use on a future satellite, probably to be launched in the early 1980s.

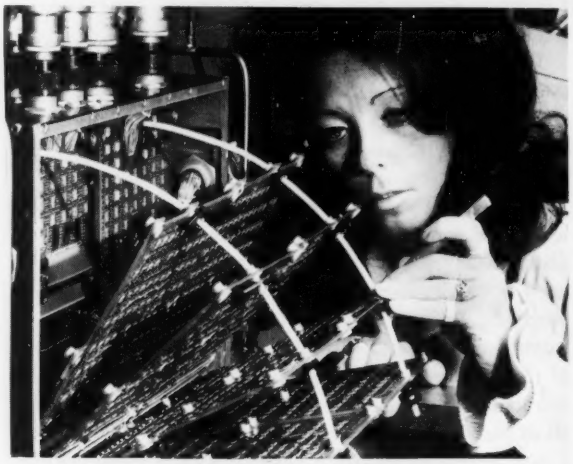
The patent for the traffic survey system is available for licensing. Information can be obtained from the Patent Attorney, Chief Counsel's Office, Marshall Space Flight Center, Ala. 35812.

Viking's Computer Slept— Like Rip van Winkle

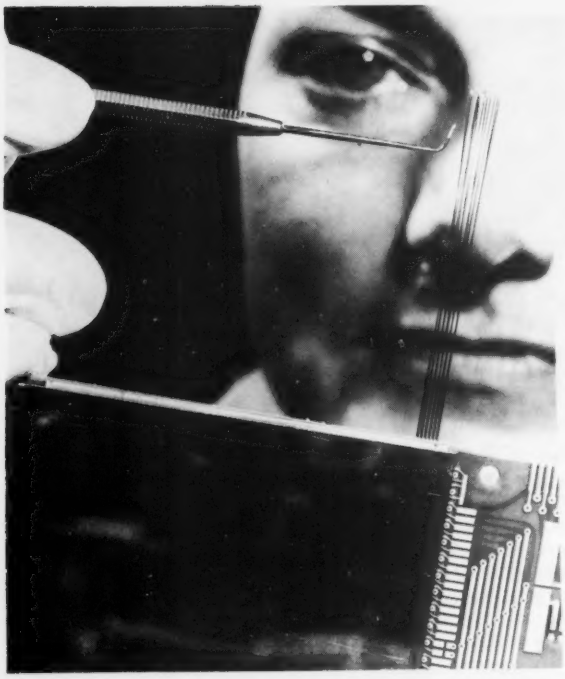
A small Honeywell HDC-402 computer, the "brain" of Vikings 1 and 2, lay dormant for more than a year as the spacecraft traveled almost half a billion miles to their rendezvous on Mars.

Like Rip van Winkle, the fabled Catskill Mountains hermit, the computer system "awakened" in an unknown land—in the strange new environs of the Red Planet. The computer was switched on just before separation of the lander from the Viking orbiter, on command from NASA's Jet Propulsion Laboratory. The system thus began to fulfill its function as it "directed" the landing and controls apparatus and equipment for scientific experiments, and transmission of processed data to Earth and to the mother orbiter.

The computer's role is considered one of the greatest technical challenges of the mission. It is a diversified role, with the Guidance, Control and Sequencing Com-



Looking for Life on Mars—The intricate guidance and sequencing of Viking's landing on Mars were controlled by this Honeywell HDC-402 computer, which looks something like the pages in a book. Here, the computer is readied for the mission during testing phases at Honeywell's Aerospace Division, St. Petersburg, Fla.



Hair-Brain—Magnetic wires as fine as human hair are inserted into a memory component of a computer by Charlotte Arnold, technician at Honeywell's Aerospace Division, St. Petersburg, Fla. Plated-wire memories like this are aboard NASA's two Viking spacecraft that landed on the surface of Mars this past summer.

puter (GCSC) involved in several elements of the mission.

During its "sleep" phases, which extended from the lift-off of the mission, the computer was tested periodically to maintain readiness. Once "awakened" by signals from Earth, the GCSC sent and received data to check out all onboard systems. During Martian orbit, it performed a diagnostic self test to determine the best performance of the identical computer channels.

Performance of the computer was pronounced outstanding by NASA and JPL officials in charge of the program.

The computer's first task was to sever mechanical and electrical ties between the orbiter and lander. Then the computer moved into the intricate, exacting control phases of the landing, slowing the lander from 15,961 to 574 kilometers (9,920 to 357 miles) per hour. Later firings of terminal descent engines, also controlled by the GCSC, slowed the lander additionally for the soft landing.

In the four-hour phase of separation, descent and landing, the GCSC commanded, controlled and guided numerous events onboard the lander, specifically:

- power up of the descent and landing systems;
- separation of lander from orbiter;
- descent-landing control, including jettison of protective aeroshell and deployment of parachute;
- generation of appropriate thrust vector control signals for soft touchdown.

All of the landing information is stored in the computer inasmuch as this is the critical phase of the mission, and transmission time for commands from Earth takes 18-plus minutes.

Once landed, the GCSC had further duties including:

- shutting off the descent and landing systems;
- orienting the direct-to-Earth S-band antenna for direct link communications;
- controlling the engineering and scientific experimental activities aboard the lander from commands received from Earth. These include geology, weather, chemistry—all experimentation.

The computer is a compact unit measuring just 1.05 cubic feet (10.5 $\times$ 10.75 $\times$ 16 inches) and weighing only 25 kilograms (52 pounds). There are two identical channels—one operational and one reserve, each containing a 25-bit, 18,432 word plated-wire memory.

To conserve electrical power the computer can operate at seven levels, from four watts in the least active mode to 35 watts in its greatest operational phase.

Lewis Center Engineer Receives Award

An impressive record of work in the heat transfer area has earned Robert G. Deissler of NASA's Lewis Research Center the honor of being named the recipient of the 1975 Max Jakob Memorial Award.

Deissler received the award Aug. 10 at the Sixteenth National Heat Transfer Conference held in St. Louis.

The award, established in 1961 and sponsored by the American Society for Mechanical Engineering and the American Institute for Chemical Engineering, is presented annually in recognition of distinguished service in the area of heat transfer. It consists of a bronze plaque, an honorarium and a certificate. In previous years the award was given to individuals from Switzerland, Germany, Russia, Japan and the United States. Max Jakob was a pioneer in the science of heat transmission.

Deissler's citation reads, "for his outstanding contributions to the theory of turbulence and turbulent transport contained in the technical literature and authoritative text books on turbulent heat transfer; for his ability to perceive and derive the fundamental theory required to advance applied research and development in convective heat transfer."

Deissler holds a B.S. degree in engineering from Carnegie Tech and an M.S. in engineering from Case Western Reserve University. He joined NASA's Lewis Research Center in 1947 and at first specialized in

fluid flow research and heat transfer. He gained early recognition in his field for a series of outstanding papers dealing with turbulent flow and heat transfer of variable property fluids in pipes or tubes. He quickly advanced to increasingly responsible positions and in 1972 was appointed technical consultant in fluid physics for the Physical Science Division.

In addition to being an active member of ASME, Deissler belongs to the American Institute of Aeronautics and Astronautics, American Physical Society, American Association for Advancement of Science and the Society for Natural Philosophy.

He received the NACA (NASA's predecessor) Exceptional Service Award in 1957, the ASME Heat Transfer Division Memorial Award in 1964, and an AIAA best paper award in 1975. Deissler has authored about 70 technical papers.

NASA Produces Film for International Outlets

Three motion pictures for the Agency for International Development recently were produced to acquaint officials in developing countries with benefits to be gained by their countries through space-age technology.

The three films: "If One Today—Two Tomorrow" (concerning communications); "Images of Life" (about Landsat); and "Survival" (disaster prediction and relief) are now being beamed to developing countries via Madrid TV and the ATS-6 satellite as a part of 90-minute television programs.

This television program, which is the introductory demonstration for project AIDSAT, is being transmitted to a different nation every three days. Thirty developing nations, starting with Pakistan on Aug. 1, are receiving the program.

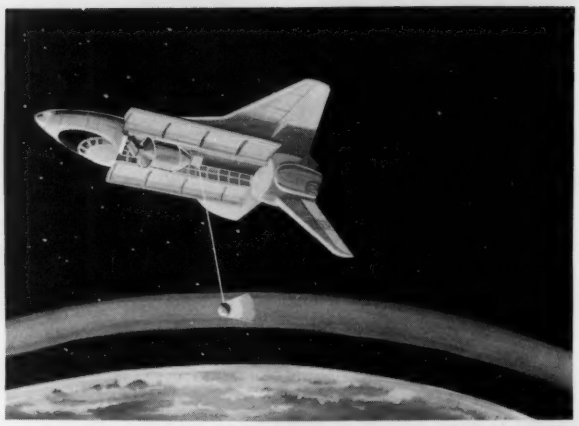
NASA's film production group took motion picture crews to South America, Africa, to the Near and Far East, and to U.S. locations to film the basic material. Production began just 90 days before the Aug. 1 airing date. The sound tracks were delivered in four languages.

Participants in the effort were the NASA Travel Office, the Office of Procurement, the Office of International Affairs, the Office of Public Affairs, the Office of Applications and a talented group of contract writers, film directors, photographers and editors.

"Satellite on a String" Study Underway

NASA scientists at the Marshall Space Flight Center are studying the feasibility of a "tethered" satellite as part of the payload of the Space Shuttle orbiter.

Consisting of a subsatellite suspended by a cable from the orbiter's cargo bay, the system could be used to deploy and control structural materials used in space station construction or to transfer articles from one manned vehicle to another.



Tied to Mother Spacecraft—The tethered satellite system (proposed) would be a payload of the Space Shuttle orbiter. The system would consist of a subsatellite suspended from the orbiter cargo bay on a long cable. It could be dragged through low-altitude Earth orbit to allow extensive scientific exploration of the atmosphere from 80 kilometers (49.7 miles) to 120 kilometers (74.5 miles) above the Earth's surface.

The tethered satellite could also be "trolled" through a low-altitude, atmospheric Earth orbit by the Orbiter to allow extensive scientific exploration of the atmospheric region extending 80 kilometers (49.7 miles) to 120 kilometers (74.5 miles) from the Earth's surface.

One reason for such exploration would be to provide more accuracy than has been previously possible in mapping the Earth's magnetic and gravity fields. Other potential applications include low Earth orbit aerodynamics studies, reentry dynamics studies and studies of temperature effects.

Previous attempts at discovering the properties of the upper atmospheric region have had only limited success, primarily because past exploration vehicles (sounding rockets and low-altitude satellites) have been unable to remain in the region for significant periods of time before atmospheric drag and gravity force them back to Earth.

If the tethered system is determined to be feasible, MSFC expects to define a project to begin spacecraft system design. Tentative planning calls for the Marshall center to manage program development, integrate the experiments and provide support for orbital operations. The first tethered satellite mission, to verify the concept, could take place as early as 1980.

Aiding NASA with its system dynamics studies for the tethered satellite system is the Smithsonian Astrophysical Observatory.

Langley Executive Takes Award—Joseph F. Braig (left), head of the Industry Assistance and Small Business Office, received a Government Achievement Award recently for his work on a minority business program carried out at the Langley Research Center. The award was presented by Wauna Dooms, executive director of the Tidewater Area Business League. Braig was cited for providing "a significant contribution to the overall program by his participation through the Small Business Administration (SBA) and the many minority committees to which he has been appointed." The program, sponsored by the SBA, is designed to help members of minority groups who, because of reasons beyond their control, have been deprived of the opportunity to develop and maintain a position in the competitive economy owing to social or economic disadvantages. Once certified as disadvantaged by the SBA, a firm then is in a position to negotiate directly with a government agency such as NASA. Braig also received the Equal Employment Opportunity Award in November 1975, and a Certificate of Appreciation from the Minority Business Opportunity Committee of Virginia for 1975-76.

Suggestion Wins Prize—Andronicos G. Kantsios (right) of the Langley Research Center, instrument research division, accepts from Donald P. Hearth, Langley director, a $1,000 check and a certificate for his suggestion that an infrared scanner be used to measure model temperatures in wind tunnels.

Presidential Award—Donald L. Riley (left), chief of the configuration management branch in the Shuttle Projects Office at the Marshall center, receives a Presidential Certificate from Dr. William R. Lucas, director. The award was for an innovation that saved the agency more than a half-million dollars in manpower and reporting costs. Riley received one of seven 1975 Presidential Management Improvement Certificates for his leadership in adapting existing configuration management techniques to the Space Shuttle program. The Presidential Certificate was accompanied by a letter of congratulations from Dr. James C. Fletcher, NASA Administrator.

Planting a "Moon Tree"—A pine tree seedling, grown from a seed carried to the Moon and back on the Apollo 14 mission in 1971, was planted in front of Marshall center's Michoud Assembly Facility administration building July 20 as a part of a Bicentennial ceremony to commemorate the anniversary of the first Moon landing. Shown at the planting are (left to right) Robert C. Littlefield, manager of Michoud; Wally Schirra, former astronaut; Verna Landrieu, wife of the Mayor of New Orleans and head of the New Orleans Bicentennial Commission; and Dr. William R. Lucas, MSFC director.

Ely Keeps on Tracking

Editor's Note: The following article is taken from the Aug. 13 NASA X-Press, house publication of the Hugh L. Dryden Flight Research Center. It tells an interesting story about one of two tracking stations that make up NASA's aerodynamic test range. (The other is at the Dryden center.) This is the first of two parts.

The mining town of Ely, Nev., 17 miles from one of NASA's tracking stations, annually suffers a week of —32 degrees Celsius (—25 degrees F.) temperatures. Considerable effort is required to keep the steep gravel road going up to the site clear of snow during the winter. Even so, once or twice a year the facility becomes inaccessible because of weather. So why would NASA build a tracking station in such an area?

The answer is that the tracking station is on a mountain at an elevation of 2,800 meters (9,200 feet) overlooking Jakes Dry Lake, originally an alternate landing site for the X-15, and because Ely is approximately in the center of one of the most used flight paths for high-altitude supersonic flights. This flight path was established because of the low population densities it covers and because of the numerous dry lakebeds available for emergency landings close to it. The station originally came into existence to support the extended flights of the X-15. In spite of the ruggedness and inaccessibility of its location, it is part of one of the most sophisticated radar tracking systems in the world, the center's Aerodynamic Test Range.

The basic elements of the facility are a radar system, a telemetry system, a communications system and a supporting computer system.

From the outside the most obvious part of the facility is the large geodesic dome covering the radar dish. The High Accuracy Instrumentation Radar (HAIR) system uses a one megawatt transmitter and a 30-foot antenna to transmit radar pulses which are reflected from the aircraft, or else cause a radar beacon on the aircraft to return a powerful pulse which is received by this same dual-purpose parabolic antenna.

The radar target is automatically tracked by the radar to give the azimuth, elevation and range of the target. This operation is controlled by the operators at a radar console specially designed for the system. A direct link to the Dryden center's radar system can be used to automatically position the radar as the target moves from the center's area to the Ely area. It has an accuracy of two yards in 32,000 nautical miles. The dome covering the dish is made out of a special de-icing fiberglass which is invisible to radar but keeps the dish from freezing or being weighted down by snow.

Telemetry is received using a Corts 469L TM system. The telemetry antenna uses either a radar link or the TM signal for tracking. Telemetry signals are sent to the center using a microwave tie allowing real-time monitoring of data at the center, and are also recorded on magnetic tape as a back-up. These tapes are sent to the center for data reduction. Using telephone lines or the microwave system the power UHF ground radio systems at the center and Ely can be operated simultaneously to insure that the flight controller in the control room at the center has constant voice contact with the pilot.

Desert Tracking Station—The Ely (Nevada) tracking station. The James Dry Lakebed adjoins the geodesic dome.

The station is supported by an on-line Scientific Data Systems Xerox computer system which makes use of such peripheral devices as a terminal, a card reader, three magnetic tape drives, a high speed printer and a random access memory.

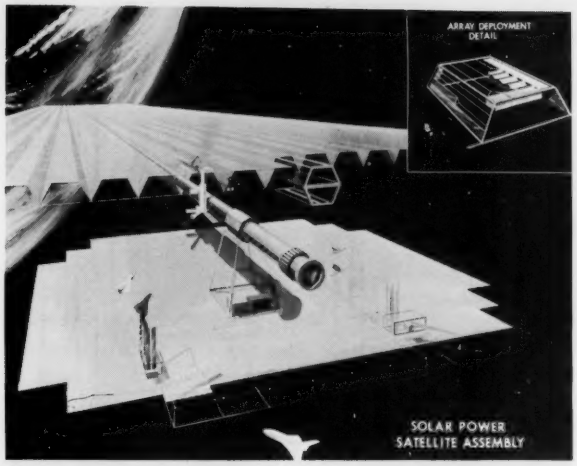
(*Continued next issue.*)

Space Prognostications

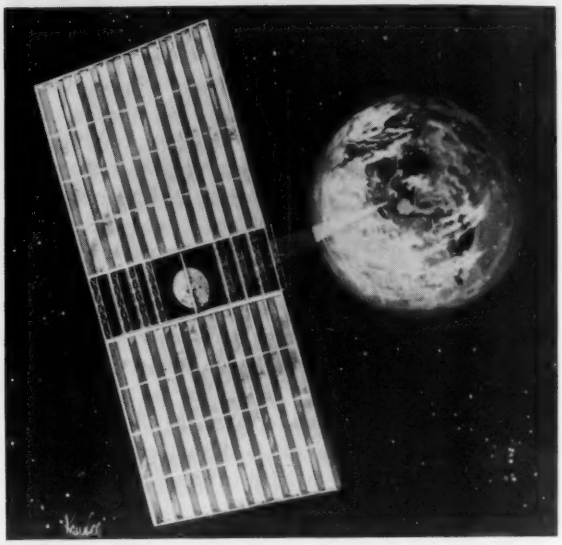
"Space industrialization" was the subject of a keynote address given at a recent symposium by John H. Disher, director of advanced programs, NASA Office of Space Flight. His remarks provide insights into the NASA philosophy concerning a universally fascinating subject.

Disher began by defining space industrialization as: "The use of space to produce a saleable/profitable product or a service which companies may deduct as a business expense or citizens through their taxes are willing to pay for . . . I believe the prospects are bright enough to say that they may form the nucleus for a third industrial revolution—some of which we've already seen."

He then touched on the general history and significance of communications satellites, and said that on a fairly conservative basis, worldwide business rates of several billion dollars a year are projected by the 1980s for the business they generate. He added:



Sun Power System—An artist's concept of one of several configurations of space-based power conversion systems under study at NASA. This type of system could be placed in orbit to collect pollution-free energy from the Sun and transmit it in the form of microwaves to Earth receiving-stations for conversion to electricity.



Solar Base in Space—Another concept of a possible satellite power system now under consideration at the Marshall center. A single system such as this might provide Earth users with 5,000 to 10,000 megawatts of electricity.

"I believe the projections to date for the most part include only growth of the type of uses experienced to date—conventional telephone and TV relay, etc., and don't adequately reflect the potential for new uses such as electronic mail, video teleconferencing, facsimile relay, personal point-to-point communications, etc."

Disher alluded to weather satellites as a good example of the service aspect of space industrialization and said that they have become indispensable in worldwide weather monitoring and long-range forecasting, adding that "their value to those elements of worldwide economy dependent on weather is incalculable. If it could be reduced to monetary terms it would, I'm sure, be staggering."

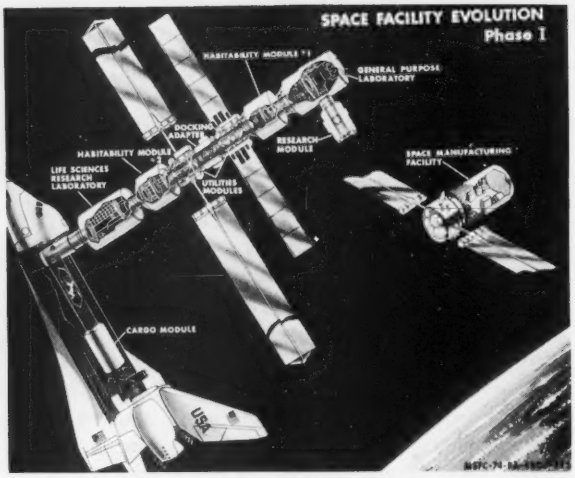
Much of Disher's talk centered on anticipated developments on the basis of space attributes. An illustration, he said, is the zero gravity effect which "makes possible processes that are unfeasible on the surface of the Earth—or on the surface of the Moon for that matter. Although gravity has many beneficial effects on Earth, such as keeping things in place, it prevents or makes very difficult many industrially valuable processes. In the absence of gravitational forces, it is possible to make some products in space that are completely unfeasible to make on Earth, such as alloys of materials that are immiscible in the presence of gravity—or products that cannot be separated out of a mixture in the presence of gravity, such as some vaccines and pharmaceuticals. It is also possible to make some things in space very much better than they can be made on Earth—giving greatly increased performance and greatly decreased cost of production. Examples here include crystals for solid-state electronic devices and certain medications.

"In addition, the absence of large gravitational forces makes feasible the fabrication and assembly of very large, extremely lightweight structures which on Earth would collapse of their own weight. This characteristic fits extremely well with the need for very large antennas in space (hundreds of feet in extent) for future space communications systems and for very large assemblies of reflectors or collectors of solar energy for use in space or on Earth.

"The absence of gravity also provides unprecedented mobility for work crews and construction equipment in space . . . it enables research into important physical and biological processes . . . for example, space hospitals are certainly not out of the question over the longer term."

He cited as other attributes of great significance: "The potential for a near perfect vacuum . . . the unlimited reservoir it [space] provides for disposal of waste heat or storage or disposal of waste products . . . the availability of essentially uninterrupted solar energy . . . and the capability space offers for essentially perpetual motion."

Looking again to the future, Disher said: "Certainly, commercial operations at levels of hundreds of millions of dollars per year can be anticipated over the next two decades. From what we know today, first commercial operations can be expected in selected electronics products and pharmaceuticals . . .



Far-Out Work Base—An artist's version of a conceptual future space station that makes use of Skylab and Spacelab technology. Through use of the building block approach, a sky-based operations facility might be established for assembly, servicing and other activities, and also for the incorporation of laboratory facilities for scientific research. The unplanned repair and servicing work done on Skylab helped lay the groundwork for this new concept.

"The unlimited reservoir of space could find first large-scale application in safe long-term storage or disposition of nuclear waste material generated on the surface of the Earth . . . this attribute plus the unlimited supply of pollution free solar energy could be most important to large-scale industrial use of space . . .

"A further opportunity for industrialization of space relates to tourism. Surely the time is not far distant when tourists will have the opportunity to experience the wonders of space through all-expense excursions to orbit. Today, people willingly pay $2,000 to fly supersonically round trip from France to South America and pay $10,000 for an all-expense cruise around the world. Within the next two decades, it should be possible to take a commercial excursion to space for comparable rates and a whole new dimension to tourism will be added—no longer will we be tied to the two dimensions of the Earth's surface."

Disher ended his address with the statement: "The questions are only when and who will take the lead. I believe it is essential that we in the United States take the lead and insure that our country continues as the industrial leader of the world."

New Manager for NSTL

Jerry Hlass (right), the newly appointed manager of NASA's National Space Technology Laboratories in Hancock County, Miss., is welcomed to the installation by deputy manager Henry F. Auter. Hlass's appointment was effective September 1. Before that, he was director of space flight facilities at NASA Headquarters. Auter, who has served as acting manager in addition to his regular duties for some time, will continue as deputy manager.

Hlass joined the headquarters staff in 1963. He came to Washington from the Goddard Space Flight Center where he served as head of the data acquisition facility section from 1961 to 1963.

Hlass holds a Bachelor of Mechanical Engineering from North Carolina State University at Raleigh, and a Master of Engineering Administration from George Washington University, Washington, D.C. He is a member of the National Society of Professional Engineers.

Biomedical Instrumentation Conference

NASA co-sponsored a conference on the transfer of biomedical instrument technology last month at the University of Connecticut Health Center, Farmington, Conn.

The conference was held to acquaint biomedical instrument manufacturers and others with the technology developed by NASA for the manned space program an dto sho whow such technology can be used to develop improved medical equipment and techniques here on Earth.

Hundreds of new and improved medical instruments and techniques based on NASA technology already are in use by the medical community. They range from bioisolation garments to the rechargeable cardiac pacemaker.

The conference program included presentations by medical experts from NASA Headquarters, the NASA Johnson Space Center, and NASA's Biomedical and Technology Applications teams, who described the types of technology available to industry and the medical community and the role NASA can play in helping to commercialize new products.

The NASA patent licensing program, offering exclusive and non-exclusive licenses, also was explained.

Other conference sponsors included the New England Research Application Center, the University of Connecticut Health Center, the Connecticut Department of Commerce and the Connecticut Product Development Corporation.

NASA Film Release

NASA has released a new motion picture entitled "UNIVERSE." It is 27 minutes in length and was over two years in production with the Graphic Films Corporation in Hollywood. Through unusual animation techniques, the motion picture explores almost inconceivable extremes of size and time—from the vast islands of stars called galaxies, to subatomic particles; from cosmic events that occurred billions of years in the past, to microcosmic events in the present that endure for only a billionth of a second. The film dramatizes a mysterious and incredibly violent universe.

Lunar Sample Exhibits

The following is a schedule of lunar sample exhibits from September 15, to October 15, 1976:

Missouri—Southeast Missouri Council, Boy Scouts of America, Sept. 21-25.
New Jersey—Franklin Mineral Museum, Franklin, Oct. 9-10.
New York—Zonta Conference in Queensbury Hotel, Glens Falls, Oct. 1-3; Ogdensburg Free Academy, Ogdensburg, Oct. 4-5.
American Freedom Train—Maryland: Baltimore, Sept. 16-20; Washington, D.C., Sept. 24-28; Virginia: Fredericksburg, Sept. 29-30; Norfolk, Oct. 2-7; Richmond, Oct. 8-12; Charlottesville, Oct. 13-14.
High Flight Bicentennial Mobile Space Museum—Alabama: Florence, Sept. 28-Oct. 3.
Tennessee Valley Association—Bicentennial Caravan—Tennessee: Lebanon, Sept. 15-16; Hartsville, Sept. 17; Lafayette, Sept. 18; Gallatin, Sept. 19-21; Springfield, Sept. 22; Clarksville, Sept. 23-24; Ashland City, Sept. 25; Erin, Sept. 26-27; Dickson, Sept. 28-29; Waverly, Sept. 30; Paris, Oct. 1-2; Lexington, Oct. 3-5; Savannah, Oct. 6; Bolivar, Oct. 7; Jackson, Oct. 8-12; Trenton, Oct. 13; Union city, Oct. 14-15.

Long Term Displays

Alabama—Alabama Space & Rocket Museum, Marshall Space Flight Center, Huntsville.
Florida—Visitor Information Center, Kennedy Space Center.
Kansas—Eisenhower Library, 200 SE 4th St., Abilene.
Mississippi—The National Space Technology Laboratories, Bay St. Louis.
New York—United Nations Building, New York City.
Ohio—USAF Museum, Wright Patterson AFB; Visitor Information Center, Lewis Research Center.
Texas—Johnson Library, University of Texas, Austin; Visitor Information Center, Johnson Space Center, Houston.
Virginia—Visitor Information Center, Langley Research Center, Hampton.
Washington, D.C.—National Geographic Museum; Smithsonian Institution, National Air and Space Museum; Washington National Cathedral.

Radio-Television

(Released Nationally)

TELEVISION: A 4 ½-minute and a 90-second film have been released in the *Aeronautics and Space Report* monthly series, entitled "Space Colonization."
RADIO: Four weekly *Space Story* programs have been released —"Florida Bicentennial Exposition" (feat. Lee Scherer and Miles Ross); "Marshall Center Activities" (feat. Dr. William Lucas); "Space Medical Benefits" (feat. Dr. Sam Pool); "Shuttle Mission Control Planning" (feat. Eugene Kranz).
One monthly NASA *Special Report* has been released—"Meal Systems for the Elderly," featuring Gary R. Primeaux, JSC.

Joint U.S.-USSR Scientific Publication Available

A three-volume edition of the joint U.S.-USSR "Foundations of Space Biology and Medicine" has been published in English by the U.S. Government Printing Office. A Russian-language version was previously published in Moscow.

The publication is the result of several years of work by the U.S.-USSR joint editorial board on Space Biology and Medicine, formed in October 1965 by NASA and the Soviet Academy of Sciences. The work summarizes the biological and medical results of the first 15 years of space flight.

The text consists of 45 chapters, 19 of which are by American scientists, 20 by Soviet scientists, and 6 by teams of authors from both nations.

The first volume is entitled "Space as a Habitat." The second, "Ecological and Physiological Foundations of Space Biology and Medicine," deals with the responses of man, plants and animals to space flight. Volume III, "Space Medicine and Biotechnology," is concerned with the technology and procedures necessary to sustain life and permit living creatures to function in space.

The complete edition in English, NASA SP-374, is in four books (Volume II has two parts) and may be purchased for $40.95 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Inventions and Contributions Board Monetary Awards

The Inventions and Contributions Board, at its meetings of August 28, September 30, October 23, and November 20, 1975, recommended that monetary awards be granted to the NASA employees and NASA contractor employees identified on the attached list for scientific and technical contributions to space and aeronautical activities. The recommendations were approved by the Administrator and the awards have been made.

Innovator(s)	Title of Invention and Contribution
AMES RESEARCH CENTER	
John Dimeff	An NDIR Gas Analyzer
Harry R. Zabower	Hand-Held Photomicroscope
GODDARD SPACE FLIGHT CENTER	
Frank Volpe	Star Scanner
John F. Sutton	Synchronized Frequency Transposer
Lester L. Millman	Power Source and Failure Monitor for Heating Fuel Quantity Meter
E. W. Chappelle, G. L. Picciolo	Assay of Flavins in Bacteria by Bacterial Bioluminescence Technique
A. C. Davidson, Grant M. McLean	Attitude Sensor
LANGLEY RESEARCH CENTER	
Franklin W. Booth, Robert A. Bruce	Centrifugal Hydrophobic Separator
Thomas T. Bales, Ashby G. Lawson, Winfrey E. Arnold, Jr.	Weld Brazing
James A. Hutchby	Graded Bandgap Solar Cell
Harry H. Becker, Hans-Juergen C. Blume	Apparatus and Method for Applying Protective Coatings
Donald J. Progar, Vernon L. Bell	Polyimide Adhesives
Donald E. Pizzeck	Connector
LEWIS RESEARCH CENTER	
Harold E. Sliney	Bearing Material
Donald L. Alger	Deuterium Pass-Through Target
J. D. Whittenberger	A Zirconium Modified Nickel-Copper Alloy
A. G. Birchenough	Electronic Analog Divider
LYNDON B. JOHNSON SPACE CENTER	
Arthur L. Schmitt	Sun Angle Calculator
Maxime A. Faget, William W. Petynia, Willard M. Taub	Space Vehicle System
Richard L. Sauer	Automatic Biowaste Sampling
Herbert S. Kobayashi	Pulse Code Modulated Signal Synchronizer
Paul W. Shou	Position Determination Systems

MARSHALL SPACE FLIGHT CENTER

Joseph H. Kerr	Traffic Survey System
Leopold A. Hein, William N. Myers	Mechanical Thermal Motor
Billy K. Davis	Solar Energy Power System
John L. Burch, James D. Johnston	Combined Docking and Grasping Device

BALL BROTHERS RESEARCH CORPORATION

R. Gutshall, R. McConaughey	Star Scanner

GENERAL ELECTRIC COMPANY

G. L. Fogal	Automatic Biowaste Sampling

HONEYWELL INCORPORATED

Irving R. Abel	Optical Instruments

INSTITUTE FOR RESEARCH INCORPORATED

Dr. Benjamin Mosier	Plated Electrodes

JOHN HOPKINS APPLIED PHYSICS LABORATORY

Carroll Pardoe	Telemetry Synchronizer

JET PROPULSION LABORATORY

Richard J. Stirn, Yea Chuan M. Yeh	Schottky Barrier Laser Energy Converter
Robert T. Menzies	Flourescence Detector for Monitoring Atmospheric Pollutants
Katsunori Shimada	Electric Power Generation System
Larry L. Schumacher	Wide Angle Sun Sensor
Rindge Shima	Improved Multiple Target Sputtering Equipment
Melvin M. Saffren	Magnetometer Using a Superconducting Rotating Sphere
Daniel D. Elleman	
Alexander Engel	Symmetrical Odd-Modules Frequency Divider
Gary A. Evans, Cavour Yeh	Fiber Distributed Feedback Laser
Edmund J. Bahm	Brushless Field Excitation of a Wound Rotor Electronically Commutated DC Stator Machine
Gary R. Russell, Noble M. Nerheim, Thomas J. Pivirotto	Inert Gas Metallic Vapor Laser
Marvin Perlman	Nonlinear Nonsingular Feedback Shift Registers
Richard J. Stirn	High Voltage, High Current SB Solar Cell
Allan R. McDougal, Robert M. Norman	Zero Torque Gear Head Wrench
Robert H. Summers, Ralph L. Kenney	An Improved Geneva Mechanism
John J. Daeges	Motor Run-Up System
Walter B. Powell, Lee R. Potter, Kenton S. MacDavid	Thermocouple Installation
Alan R. Johnston	Cooperative Multiaxis Sensor for Teleoperation of Article Manipulating
Ernest Z. Micka	Automatic Visual Inspection System for Microelectronics
Marvin K. Simon	Decision Feedback Loop for Tracking a Polyphase Modulated Carrier
Tage O. Anderson	Multi-Computer Multiple Data Path Hardware
Robert C. Clauss	Reflected Wave Maser
Katsunmori Shimada	Thermostatically Controlled Non-Tracking Type Solar Energy
Charles Elachi	Fiber Distributed Feedback Laser

KENTRON

Anne Flippin	Sun Angle Calculator

LOCKHEED ELECTRONICS COMPANY

Wally M. Wallingford, Philip M. Hopkins	Differential Phase-Shift-Keyed Signal Resolver

Phillip C. Lipoma	Data Storage, Image Tube Type
George Eugene Proch	Digital Transmitter for Data Bus Communications System
MARTIN MARIETTA CORPORATION	
Donald J. Bottoms Theofanis G. Gavrillis	Turnstile and Flared Cone UHF Antenna
Orval W. Wade	Method and Apparatus for Tensile Testing
Kenneth Daniels Leo J. Rothermel Dennis E. Herrick	A Device Responsive to Applied Torque for Grasping an Elongated, Externally Threaded Body
McDONNELL DOUGLAS CORPORATION	
Larry R. Eaton	An Improved Heat Transfer Device
NATIONAL ACADEMY OF SCIENCES	
James J. Cowan	Holographic Device
NATIONAL RESEARCH COUNCIL	
Biliyar N. Bhat	Method of Growing Composites
NATIONAL RESEARCH DEVELOPMENT CORPORATION	
Francis T. Bacon	Bacon Hydrogen-Oxygen Fuel Cell Technology
RCA CORPORATION	
Wayne A. Harmening	Preloaded Torque Limiting Shaft Coupling
ROCKWELL INTERNATIONAL CORPORATION	
Wayne F. Dyer J. D. Jay Ira Phillips E. Copeland	Coldplate Heat Exchanger
Charles S. Beuyukian Wayne R. Johnson	Brazing Process Using Al-Si Filler Alloy Reliability Bonds
SANDIA CORPORATION	
Wayne A. Sebrell	Inflatable Wing
SPERRY RAND	
Ray E. Marlow	An Improved System for Enhancing Tool Exchange Capabilities of a Portable Wrench
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY	
Terry L. St. Clair	Polymide Adhesives

Launches for 1976—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
Helios-2	Jan. 15	Titan/Centaur	ETR	Scientific satellite to investigate the properties of interplanetary space close to the Sun. Cooperative with Germany.
CTS	Jan. 17	Delta	ETR	Experimental high-powered communications satellite. Cooperative with Canda.
Intelsat IVA-F2	Jan. 29	Atlas/Centaur	ETR	Comsat communications satellite—reimbursable.
Marisat-1	Feb. 19	Delta	ETR	Comsat maritime communications satellite—reimbursable.
RCA-B	March 26	Delta	ETR	Second RCA (Satcom) domestic communications satellite. Reimbursable.
NATO-III A	April 22	Delta	ETR	Communications satellite for the North Atlantic Treaty Organization—reimbursable.
Lageos-1	May 4	Delta	WTR	To demonstrate relevant space techniques that will contribute to the development and validation of predictive models for earthquake hazard alleviation, ocean surface conditions and ocean circulation.
Comstar-1	May 13	Atlas/Centaur	ETR	Domestic communications satellite for Comsat. Reimbursable.

Air Force Test	May 22	Scout	WTR	USAF scientific payload. Reimbursable.
Marisat-B	June 9	Delta	ETR	Second Comsat satellite to provide maritime satellite communications service. Reimbursable.
Relativity	June 18	Scout	Wallops	Scientific probe to test the Einstein Theory.
Indonesia-A (Palapa)	July 8	Delta	ETR	Indonesian communications satellite. Reimbursable.
Comstar-B	July 22	Atlas/Centaur	ETR	Second domestic communications satellite for Comsat. Reimbursable.
ITOS-E2	July 29	Delta	ETR	Operational meteorological satellite of the National Weather Service to provide day and night cloud cover imagery. Reimbursable.
Navy Transit	July 30	Scout	WTR	Navy navigation satellite. Reimbursable.
Marisat-C	Oct. 14	Delta	ETR	Third Comsat satellite to provide maritime satellite communications service. Reimbursable.
NATO-III-B	Dec. 2	Delta	ETR	Second of a series of communications satellites for the North Atlantic Treaty Organization. Reimbursable.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel for the indicated installation.

Inventor(s) and Employer(s)	Title & NASA Docket	Patent No.	Installation
Ernest M. Cohn, NASA/Hdqs	Rechargeable Battery which Combats Shape Change of the Zinc Anode	3,972,727	NASA Hq.
Richard F. Haines, James W. Fitzgerald, Salvadore A. Rositano, NASA/ARC	Visual Examination Apparatus	RE 28921	ARC
Charles C. Kirsten, Caltech, Pasadena, Calif.	Solar-Powered Pump	3,972,651	NRLO
Joseph L. Horner, Dept. of Transportation, Cambridge, Mass.	Optical Noise Suppression Device and Method	3,977,771	JSC
Alain L. Fymat, Caltech/JPL, Pasadena, Calif.	High-Resolution Fourier Interferometer-Spectrophotopol Arimeter	3,977,787	NRLO
Robert S. Rogowski, Edmund J. Conway, NASA/LARC, Ralph R. Richards, Old Dominion Univ., Norfolk, Va.	Method for Detecting Pollutants	3,977,831	LARC
Jung P. Hong, Caltech/JPL, Pasadena, Calif.	Real Time Analysis of Voiced Sounds	3,978,287	NRLO
Louis C. Maus, Sperry Rand Corp., Huntsville, Ala., Donald E. Williams, NASA/MSFC	Dual Mode Solid State Power Switch	3,978,350	MSFC
Lawrence William James, Varian Associates, Palo Alto, Calif.	III V Photocathode with Nitrogen Doping for Increased Quantum Efficiency	3,978,360	NRLO
Robert Manoli, Bertram R. Ulrich, Rockwell Inter., Downey, Calif.	Aircraft-Mounted Crash-Activated Transmitter Device	3,978,410	MSFC
Robert C. Clauss, Caltech/JPL, Pasadena, Calif.	Reflected-Wave Maser	3,978,417	NRLO
Lott W. Brantley, Jr., NASA/MSFC	Thermal Energy Storage System	3,977,197	MSFC
Carl L. Haehner, John L. Tarpley, NASA/GSFC	Static Coefficient Test Method and Apparatus	3,977,231	GSFC
Howard F. Broyles, Jovan Moacanin, Edward F. Cuddihy, Caltech/JPL, Pasadena, Calif.	Method of Making Hollow Elastomeric Bodies	3,978,187	NRLO
Morris A. Barnett, Caltech/JPL, Pasadena, Calif.	Furlable Antenna	3,978,490	NRLO
Meyer M. Gilman,, Rockwell Inter Corp., Space Div., Downey, Calif.	Flanged Major Modular Assembly Jig	3,977,147	JSC
John Dimeff, William J. Kerwin, NASA/ARC	Integrated Structure Vacuum Tube	3,978,364	ARC
Ralph S. Hafle, Baldwin Electronics, Inc., Little Rock, Ark.	Digital Plus Analog Output Encoder	3,976,997	GSFC

Are you getting your **1 cent** worth from **NASA**?

For a penny of your tax dollar, you are getting, among other things

Superior Performance by Earthbound Wheels

A better automobile tire from NASA's Viking mission to Mars is an unexpected bonus that promises to increase the safety of wheels carrying vehicles along this planet's motor highways.

The superior tires are made of a new Du Pont fiber, the product of a special research effort to assure a soft and gentle touchdown on Mars by the Viking landers. The fiber was used in the shroud lines of the parachutes that floated the two landers gently onto the Martian surface in July and September.

Three straps made of the material attached to the parachute and harnessed to the 1,000-kilogram (2,300-pound) instrumented lander were strong enough to withstand the gravitational pull of Mars and thus ease the descent of the robot visitor from Earth.

What makes the Du Pont fiber so strong? According to materials specialists, the strength is because of its chainlike molecular structure.

The fiber now is being tested for use by the Goodyear Tire and Rubber Company as material for the cords of a space-age radial tire for earthly transportation. Addition of the fiber in the new radial tire has resulted in an estimated increase of tread-life of about 10,000 miles as well as increased traction, a vital factor for safety on slick and icy roads.

It is worth noting that this is not the first improvement in automobile tires for Earth that has resulted from space research.

The Apollo 14 mission and the mobile cart ("rickshaw"), pulled on the lunar surface by Astronaut Alan Shepard, gave rise to the studless winter tire. The tires on the wheels of rickshaw were made of specially treated rubber able to retain form and pliability at the temperature extremes of hot and cold characteristic of the lunar environment. Developed by Goodyear Tire and Rubber Company for NASA's Johnson Space Center in Houston, the rubber tires made for Rickshaw remained pliable even at minus 195° F.

Subsequently, Goodyear used the flexible and pliable rubber to fabricate a radial tire for use in cold weather on Earth. Far more pliable at low temperatures, the new tire provided greater traction than snow tires of conventional rubber. At below-freezing temperatures, tires of conventional rubber harden and tend to bounce. Traction is substantially less and safety is reduced.

The Mars-inspired fiber may provide tires with even better traction and greater safety than those made from the Apollo 14 temperature-resistant and pliable rubber. These new tires should be available soon to the general public.

A Tire for All Seasons—A new fiber, developed primarily to withstand the weight and gravitational pull of the Martian surface as the Viking landers were set down, is incredibly strong in proportion to its weight. On a pound-for-pound basis, its strength is *five times* that of steel. Here, Goodyear Tire and Rubber Co. researchers use caliphers to test a cut-apart section to evaluate the potential performance of the 10-corded tire.

NASA

National Aeronautics and Space Administration

"For the benefit of all . . ."

AMERICAN REVOLUTION BICENTENNIAL 1776-1976